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Book of Abstracts

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4-Dimensional Particle Tracking with Ultra-fast Silicon Detectors

Authors: Carolyn Gee[1] ; Zachary Galloway[None] ; Simone Mazza[None] ; Hendrik Ohldag[None] ; Hartmut Sadrozinski[None] ; Bruce Schumm[None] ; Abe Seiden[None] ; Max Wilder[None] ; William Wyatt[None] ; Yuzhan Zhao[None]

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Measurement of charged particle trajectories is ubiquitous in applications of physics to a wide variety of areas and is essential for making measurements in high energy particle physics experiments. Silicon sensors are good for measurement of charged particles due to their resistance to radiation, high spatial granularity across large array areas, as well as their ability to collect data at very high rates. By adding an additional doping layer of p+ material (Boron or Gallium) close to the n-p junction in an n-in-p sensor, we create a new type of sensor with a large electric field and high doping concentration near the junction. This new type of thin sensor is a Low Gain Avalanche Detector (LGAD), which is capable of measuring tens-of-picosecond pulses at a rate of 500 MHz and achieving millimeter position resolution from low-energy x-ray, photon, and ⊠-particle sources. This improved fast timing resolution is necessary for LHC particle tracking to determine particle arrival times. Arrays of these LGADs allow for coverage of large detection areas. In addition, a novel type of AC coupled LGAD (AC-LGAD) is characterized by unsegmented sheets of the p-multiplication layer, the n-implant and a coupling oxide with a segmented metal contact on top. Continuous collection electrodes read out by segmented contacts allow for excellent position resolution. AC-LGAD will allow improved simultaneous measurements of deposited energy, position, and time.

Session:

Works in Progress (15+5 min)

Lightning Talks / 35

A Study of Grid Electron Emission in LZ using a Gaseous Xenon Test Vessel at SLAC

Author: Ryan Linehan[1]

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To observe signals from low-energy nuclear recoils, including WIMP-xenon scatters, the LZ dark matter detector must maintain strong drift and extraction fields within its dual-phase xenon Time Projection Chamber (TPC). We will accomplish this with a set of four stainless steel wire mesh high voltage grids placed at various heights in the TPC. Because the grid wires are regions where electric fields may be as large as 50 kV/cm on a cathodic surface, it is important for LZ to understand backgrounds due to spurious electron emission from these wire surfaces. The Phase 2 System Test detector, built at SLAC, is a gaseous xenon test stand used to study high voltage behavior of some full-scale prototypes of LZ's grids, as well as the final LZ grids themselves. This talk will discuss preliminary results from this test stand and comment on the strategies being used to understand the electron emission background from the grids.

Session:

Lightning Round (5+3 min)

Lightning Talks / 32

A new method for silicon sensor charge calibration using Compton scattering

Authors: William Mccormack[None] ; Maurice Garcia-Sciveres[None]

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As silicon sensors become increasingly thin, the threshold for charge detection decreases, making a calibration of the sensor's charge sensitivity with traditional sources difficult. We present a new method for charge sensitivity calibration using the Compton scattering of photons emitted from an radioactive source or x-ray generator. The electron scattered from the photon ranges out near the point of scattering, ionizing the silicon. An accurate measurement of the scattering angle of the photon, made possible by the use of a spectrometer attached to a pivot, allows for precise knowledge of the deposited charge. In the past, this method has been used for calibration of scintillators, but to our knowledge never for silicon detectors; in particular, here it has been studied using a 150 micron silicon sensor on an RD53a chip.

Session:

Lightning Round (5+3 min)

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ATLAS HGTD Upgrade

Authors: Mazza Simone Michele[1] ; Yuzhan Zhao[1]

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In 2014-2025 the ATLAS detector at LHC (CERN, Geneva) will be upgraded to withstand the high pileup expected at HL-LHC. The inner tracker will be completely renewed with the ITk project and other parts detectors will be upgraded. HGTD will probably be included in the list of upgrades, it consist in 4 (yet to be confirmed) layers of pixel LGADs detectors in the pseudorapidity region of 2.4 to 4.2. LGADs (low gain avalanche detectors) are silicon detector with an additional multiplication layer with gain of ~10, thanks to the high rise of the signal pulse these detector can reach the exceptional time resolution of 30ps. In the talk a brief summary of the HGTD project will be given alongside the physics motivations, a part of the talk will be dedicated to LGAD technology.

Session:

Works in Progress (15+5 min)

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Applying Deep Learning Techniques for LArTPC Data Reconstruction

Authors: Laura Domine[1] ; Kazuhiro Terao[2]

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Deep Learning is making revolutionary advancements in the field of artificial intelligence and computer vision (CV). Recently successful applications of Convolutional Neural Networks (CNNs), a type of Deep Learning (DL) algorithm, include analyzing data recorded by liquid argon time projection chambers (LArTPCs), a class of particle imaging detectors that can record the trajectory of charged particles in either 2D image or 3D volumetric data. These algorithms aim to fully exploit the detailed topological and calorimetric information recorded by LArTPCs with breathtaking resolution (~3mm/pixel). Our research focus is to build a full chain of DL-based data reconstruction algorithms for LArTPC data. The applications of our algorithm include interaction vertex localization, electromagnetic shower particle identification at the pixel-level, and clustering of energy depositions. I present recent progress made on our research for reconstructing 2D and 3D LArTPC data.

Session:

Works in Progress (15+5 min)

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Close out

Lightning Talks / 46

Development of Suitable Dielectrics for the High Luminosity LHC

Author: Selene Cheung[1]

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The tracking detectors at the High Luminosity Large Hadron Collider will require a dielectric capable of withstanding the high voltage that will be applied across their silicon sensors to maintain efficiency. Dielectrics are currently being studied using experimental device configurations which are electrostatically analogous to the LHC trackers to determine the most effective material to prevent this breakdown. Factors that influence breakdown such as time, air gaps, ambient temperature, and processing variables are being investigated as the second phase to this project to characterize our dielectrics. This talk will present the various experimental configurations and the results of these tests.

Session:

Lightning Round (5+3 min)

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Illuminating the Hbb Discovery at ATLAS with the VBF + photon channel

Author: Jacob Pasner[1]

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After the discovery of the Higgs Boson in 2012 a major goal for Higgs physics is the more precise measurement of its couplings, especially that of its dominant but largely unconstrained decay to bb. Beyond the importance of this measurement to our understanding of the SM, these constraints also serve as a probe of new physics beyond the SM. This year the ATLAS collaboration leveraged the combined Run 1 and Run 2 datasets and the power of multiple analyses to produce a 5.4 sigma (observed) discovery of Hbb. In this talk I will discuss the VBF analysis which found a 1.9 sigma (observed) signal strength for Hbb using a 30.6/fb dataset at 13 TeV. This analysis took advantage of the inclusion of a final state photon to reject QCD background process as well as innovations in bottom quark pT reconstruction to improve the final fit result.

Session:

Works in Progress (15+5 min)

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Improvement of Jet Substructure Techniques by Studying HH -> WWWW -> Hadrons with the CMS Experiment

Author: Brendan Regnery[1]

Co-authors: Robin Erbacher [1] ; Justin Pilot [1] ; John Conway [1]

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Theories beyond the Standard Model of particle physics predict increased production of two Higgs bosons (HH). Searches for HH production often involve hadronic final states that deal with large backgrounds. Recently, there has been an increase in new jet substructure techniques that utilize machine learning algorithms. These algorithms may be able improve the signal to noise ratio in HH searches. The Boosted Event Shape Tagger (BEST) is a Neural Network that utilizes jet substructure, but has not yet been applied to searches for HH. A particularly interesting HH process that has not yet been explored is HH→WWWW→hadrons. This process has a unique hadronic final state that is being used for creating a new HH specific neural network based off of BEST. The Hadronic diHiggs Event Shape Topology Identification Algorithm (HHESTIA) is being trained with this process for use with collision data from the Compact Muon Solenoid (CMS) experiment at the European Organization for Nuclear Research (CERN). This procedure can serve as a guide for altering BEST to use with searches for HH production and searches for diboson production. This presentation will focus on early work and future plans for HHESTIA.

Session:

Works in Progress (15+5 min)

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Introduction and Welcome

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Jet reclustering in Mono-S(WW) signature analysis

Author: Congqiao Li[1]

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Jet reclustering method is a novel tool to reconstruct large-radius jet. This study implements jet reclustering procedure in the search for dark matter production associated with Higgs-like scalar boson decaying to W^+W^- at ATLAS, also known as Mono-S(WW) signature. The performance of reconstructing four highly-boosted jets in the signal sample is inspected, and a better result in mass resolution is expected compared with the conventional large-R jet.

Session:

Works in Progress (15+5 min)

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LArPix R&D: Demonstration of large-area 3D charge readout for LArTPCs

Author: Peter Madigan[None]

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We have recently demonstrated 3D charge readout of LArTPCs using a custom cryogenic ASIC and an industry-standard PCB collection plane. This system (LArPix) achieves unambiguous readout by instrumenting each pad of the charge collection plane with a uniquely identifiable channel of a LArPix ASIC. Each LArPix ASIC provides charge amplification, digitization, and digital multiplexing for up to 32 channels. An array of ASICs can then be deployed to instrument the full anode area. LArPix utilizes industry standard practices to allow for scale-up with low production costs. This enables the use of large-area LArTPCs in high-rate environments, such as the DUNE near detector. I will present on the initial results and current status of the LArPix R&D effort.

Session:

Works in Progress (15+5 min)

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Low Energy Nuclear Recoil Events in Liquid Xenon

Author: Daniel Naim[None]

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Low energy nuclear recoil events are of great interest in the search for Dark Matter, specifically for probing lower mass WIMP models. They also give us a better understanding when developing advanced detectors for reactor antineutrino monitoring. LLNL and UC Davis are collaborating to study ~ 1 keV Nuclear Recoils in a liquid xenon using a dual phase time projection chamber (XeNeu). In this talk I will present preliminary results of 2.4 MeV neutron recoils from a DD generator and

compare them to LUX ionization results. Then briefly discuss our charge yield measurements for sub-KeV recoils taken at TUNL's 570 KeV neutron source.

Session:

Works in Progress (15+5 min)

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Measurement of Neutrino Cross Section with IceCube using Earth Absorption

Author: Sally Robertson[1]

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The IceCube observatory located at the South Pole detects high energy neutrino's from atmospheric and astrophysics sources. Neutrinos are weakly interacting particles but at high energies neutrinos will be absorbed while traveling through the Earth. The Earth absorption can be used to fit for the neutrino cross section at TeV energies, well above accelerator measurements. A previous study published the results for one year of IceCube data, this new analysis will use 8 years of data reducing statistical errors and using improvements in the systematics.

Session:

Works in Progress (15+5 min)

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Measurement of superradiance in liquid xenon with DireXeno

Author: Ran Itay[1]

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Liquid xenon time projection chambers lead the field of dark matter direct detection and over the past decades, their volume have gradually increased, now reaching ton-scales. However increasing the volume is not enough, and more sophisticated background reduction techniques are needed. Shielding the detectors is fully exploited and the next generation of multi-ton detectors (e.g., DARWIN) will have to improve the discrimination of signal from background. These detectors will also reach the "neutrino floor" which is considered an irreducible background. In this talk I will present a new method for background reduction using effects of superradiance in liquid xenon. I will describe an experimental setup which aims to measure the temporal and spatial scintillation patterns of scatter events in liquid xenon. The apparatus is designed to hold a small bubble of liquid xenon surrounded by PMTs in 4π.

Session:

Thesis Presentations (30+10 min)

Lightning Talks / 42

PSD capabilities of a SiPM-based Readout Board

Author: Jyothisraj Johnson[1]

[1] *UC Davis*

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Much work has already been done developing a compact fast neutron camera for field deployment. However, mobility of the current designs are limited in part by the inclusion of large photomultiplier tubes (PMTs). Replacement of PMTs with silicon photomultipliers (SiPMs) coupled to a crystal scintillator promises a reduction in size and power, and thus an increase in mobility of current systems. This presentation will be a broad overview of a proof of concept board that can do PSD between fast neutrons and gammas for a single channel from a SiPM array. After testing, the goal will be to scale to multiple channels.

Session:

Lightning Round (5+3 min)

Lightning Talks / 31

Probing new physics using non-pointing and delayed photons with the ATLAS detector

Author: Sai Santpur[None]

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ATLAS detector's Liquid Argon electromagnetic calorimeter is capable of precisely measuring photon's timing and pointing. This allows us to uniquely probe physics beyond the standard model that involves neutral long-lived particles that decay into photons. In this presentation, I will describe how ATLAS measures photon pointing and timing, summarize the results from Run 1 analysis and shed a light on the on-going Run 2 analysis.

Session:

Lightning Round (5+3 min)

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Scintillation Response Linearity of Nuclear Recoils in High Pressure Helium Gas

Author: Andreas Biekert[1]

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We present an ongoing analysis of an experiment measuring the scintillation response linearity of high pressure helium-4 gas to nuclear recoils using a commercial fast neutron detector. The Arktis Fast Neutron Detector S670 is a tube filled with high pressure natural helium gas and several silicon photomultiplier (SiPM) light detectors, which collect scintillation light produced by particle interactions in the detector. We use a monoenergetic source of 2.8 MeV neutrons from a DD generator and an organic scintillator detector to tag neutrons scattering into a particular recoil angle and therefore fix the energy deposited into the helium gas. We analyze the linearity of the scintillation response of the detector down to a recoil energy of 83 keV by comparing the experimental data to Monte Carlo simulations of the experimental setup. We also present some of the advantages and pitfalls of using a commercial detector for such a measurement.

Session:

Works in Progress (15+5 min)

Thesis Presentations / 53

Search For a Light Pseudoscalar Higgs Boson with Boosted Topologies at CMS

Authors: Mengyao Shi[None] ; Maxwell Chertok[1] ; John Gunion[1] ; Redwan Habibullah[2] ; Evan Hargett[2] ; Grace Haza[1] ; Anirban Saha[2] ; Devin Taylor[1] ; Kyle Tos[1] ; Rachel Yohay[2] ; Fengwangdong Zhang[1]

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A search is performed for a light pseudoscalar Higgs boson (a) motivated by the theoretical framework of two higgs doublet plus singlet models (2HDM+S). This search uses 2016 LHC data collected at 13 TeV by the CMS experiment, and analyses the decay channel H->a a->mu mu tau tau, with H being either the 125 GeV state or heavier Higgs boson. Final state tau leptons feature a boosted and collimated topology due to the difference between the H and a masses. Thus, a novel algorithm for this special final state is designed to increase the identification efficiency. Expected limits are derived in the context of four types of 2HDM+S models for H(125), and are complementary to current CMS results with resolved final state particles. Model-independent expected limits for heavier H masses are also presented.

Session:

Thesis Presentations (30+10 min)

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Search for a Dark Photon with the Heavy Photon Search Experiment

Author: Matthew Solt[None]

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The Heavy Photon Search experiment took its first data in a 2015 engineering run using a 1.056 GeV, 50 nA electron beam provided by CEBAF at the Thomas Jefferson National Accelerator Facility, searching for an electro-produced dark photon. Using 1.7 days (1170 nb^{-1}) of data, a search for a resonance in the e^+e^- invariant mass distribution between 19 and 81 MeV/c^2 showed no evidence of dark photon decays above the large QED background, confirming earlier searches and demonstrating the full functionality of the experiment. Upper limits on the square of the coupling of the dark photon to the Standard Model photon are set at the level of 6×10^{-6}. In addition, a search for displaced dark photon decays did not rule out any territory but resulted in a reliable analysis procedure that will probe hitherto unexplored parameter space with future, higher luminosity runs. Results from both the 2015 resonance and displaced dark photon searches will be presented as well as plans for future data analysis and running.

Session:

Thesis Presentations (30+10 min)

Lightning Talks / 52

Search for light pseudoscalar with overlapping di-tau decays using machine learning at the CMS detector

Author: Grace Haza[1]

[1] *University of California Davis (US)*

Corresponding Author: gmhaza@ucdavis.edu

Recent LHC searches have probed decays of the H(125) involving new light pseudoscalar bosons (a). For example, a current CMS search probes H->aa->mu mu tau tau for m(a) < 21 GeV. Because of the large mass difference between the H and the light pseudoscalar, the two taus are boosted and collimated. To improve signal acceptance for future studies, we explore the use of machine learning techniques to distinguish between overlapping di-tau decays and light QCD jets. We first investigate kinematic characteristics of hadronic tau decays compared to light QCD jets.

Session:

Lightning Round (5+3 min)

Works in Progress / 54

Search for vector-like top quark partners decaying to an all-jets final state using pp collisions at $\sqrt{s}$ = 13 TeV

Author: Reyer Edmond Band[1]

[1] *University of California Davis (US)*

Corresponding Author: rband@ucdavis.edu

We present a search for the pair production of a vector-like, charge 2/3e quark "T", in the all-hadronic final state. Proton-proton collisions at $\sqrt{s}$ = 13 TeV are analyzed using 35.9 fb−1 of data collected by the CMS detector at the Large Hadron Collider during 2016 collisions. We utilize boosted substructure techniques, including N-subjettiness and soft drop mass to identify vector boson hadronic decays. This search optimizes sensitivity to the T->bW decay, but provides interpretations and limits

for all possible decays of the T. The results of this cut-based search are complementary to results of a search utilizing the BEST neural-net tagger.

Session:

Works in Progress (15+5 min)

Works in Progress / 33

Statistical analysis in ttbar resonance search with ATLAS

Author: Tong Ou[1]

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This study focuses on the statistical analysis of the ongoing $t\bar{t}$ resonance search at ATLAS, which aims at searching for new heavy particles decaying to a top quark pair in fully hadronic final state with full Run 2 data. In this study, BumpHunter is employed to search for deviation from a smoothly falling background prediction, while Frequentist CLs method is used to set upper limit for cross section in absence of significant deviation.

Session:

Works in Progress (15+5 min)

Lightning Talks / 44

Study of Radiation Hard Dielectric Materials for the High Luminosity LHC

Author: Derikka Bisi[1]

[1] *UC Davis*

Corresponding Author: dabisi@ucdavis.edu

As the High Luminosity Large Hadron Collider (LHC) upgrade approaches, a suitable dielectric material will be needed to provide electrical isolation between the silicon detectors and readout electronic chips in the next generation of trackers. An ideal dielectric candidate for the upgrade should survive the high radiation environment of the LHC, provide high resistivity for isolation, and possess a high dielectric strength to prevent electrostatic discharge. Dummy assemblies were built and experimentally tested with the dielectric materials that fit the above criteria after surviving exposure to various levels of radiation. Details of the testing apparatus, measurement sequences, and radiation exposures will be presented along with some preliminary results on a set of materials.

Session:

Lightning Round (5+3 min)

Works in Progress / 39

Study of the rare decays of Bs0 and B0 into muon pairs from data collected during 2015 and 2016 with the ATLAS detector.

Author: Aidan Grummer[1]

[1] *ATLAS Collaboration*

Corresponding Author: agrummer@cern.ch

A study of the decays $B_s^0 \to ^{+-}$ and $B^0 \to ^{+-}$ has been performed using 26.3 fb^{-1} of 13 TeV LHC proton-proton collisions collected with the ATLAS detector in 2015 and 2016. For B_s^0, the branching fraction $BR(B_s^0 \to ^{+-}) = (3.2^{+1.1}_{-1.0}) \times 10^{-9}$ is measured. For the B^0, an upper limit on the branching fraction is set at $BR(B^0 \to ^{+-}) < 4.3 \times 10^{-10}$ at 95 confidence level. The result is combined with the full Run 1 ATLAS result, yielding $BR(B_s^0 \to ^{+-}) = (2.8^{+0.8}_{-0.7}) \times 10^{-9}$ and $BR(B^0 \to ^{+-}) < 2.1 \times 10^{-10}$. The combined result is consistent with the Standard Model within 2.4 standard deviations.

Session:

Works in Progress (15+5 min)

Lightning Talks / 30

Test

Author: Benjamin Nachman[None]

Corresponding Author: bpnachman@lbl.gov

Test

Session:

Thesis Presentations (30+10 min)

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The Accelerator Neutrino Neutron Interaction Experiment (ANNIE): measuring the neutron multiplicity from neutrino-nucleus interactions

Author: Teal Pershing[1]

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Energy reconstruction of neutrino interactions in long-baseline experiments is heavily driven by the kinematics of leptons produced in charged-current interactions. Accurate reconstruction often relies on selecting charged-current quasi-elastic (CCQE) events, containing no particles other than the nuclear recoil and the produced lepton, while rejecting inelastic events mimicking a CCQE interaction (CCQE-like). One large indicator of an event's inelasticity is the presence of final-state neutrons;

having an understanding of the expected number of neutrons following CCQE-like inelastic events is key to tagging inelastic events. A measurement of the neutron multiplicity in neutrino interactions on water can also help constrain and refine models of neutrino-nucleus interactions. ANNIE (Accelerator Neutrino Neutron Interaction Experiment) is a gadolinium-doped water Cherenkov detector that will measure the number of neutrons produced following charged-current events caused by muon neutrinos in the Fermilab Booster Neutrino Beam line. ANNIE will also be the first neutrino experiment to deploy Large Area Picosecond Photodetectors, photosensors with ~60 ps time and <1 cm position resolutions, with the primary purpose of improving final-state muon reconstruction. This talk will provide an overview of the ANNIE detector, ANNIE Phase I results (background measurements), and current progress on ANNIE Phase II

Session:

Works in Progress (15+5 min)

Lightning Talks / 45

The GAmmas from Nuclear Decays Hiding from Investigators (GANDHI) Experiment

Authors: Surjeet Rajendran[None] ; Alexey Drobizhev[None] ; Harikrishnan Ramani[None]

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We propose a high statistics experiment to search for invisible decay modes in nuclear gamma cascades. A radioactive source (such as 60Co or 24Na) that triggers gamma cascades is placed in the middle of a large, hermetically sealed scintillation detector, enabling photon identification with high accuracy. Invisible modes are identified by establishing the absence of a photon in a wellidentified
gamma cascade. We propose the use of fast scintillators with nanosecond timing resolution, permitting event rates as high as 107 Hz. Our analysis of the feasibility of this setup indicates that branching fractions as small as 1E−12 − 1E−14 can be probed. This experimental protocol benefits from the fact that a search for invisible modes is penalized for weak coupling only in the production of the new particle. If successfully implemented, this experiment is an exquisite probe of particles with mass below ~4 MeV that lie in the poorly constrained supernova "trapping window" that exists between 100 keV - 30 MeV. Such particles have been invoked as mediators between dark matter and nucleons, explain the proton radius and $(g-2)\mu$ anomalies and potentially power the shock wave in type II supernovae. The hadronic axion could also be probed with modifications to the proposed setup.

Session:

Thesis Presentations (30+10 min)

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The Light Dark Matter eXperiment

Author: Omar Moreno[1]

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The Light Dark Matter eXperiment (LDMX) proposes a high-statistics search for low-mass dark matter in fixed-target electron-nucleus collisions. Ultimately, LDMX will explore thermal relic dark matter over most of the viable sub-GeV mass range to a decisive level of sensitivity. To achieve this goal, LDMX employs the missing momentum technique, where electrons scattering in a thin target can produce dark matter via "dark bremsstrahlung" giving rise to significant missing momentum and energy in the detector. To identify these rare signal events, LDMX individually tags incoming beam-energy electrons, unambiguously associates them with low energy, moderate transverse-momentum recoils of the incoming electron, and establishes the absence of any additional forward-recoiling charged particles or neutral hadrons. LDMX will employ low mass tracking to tag incoming beam-energy electrons with high purity and cleanly reconstruct recoils. A high-speed, granular calorimeter with MIP sensitivity is used to reject the high rate of bremsstrahlung background at trigger level while working in tandem with a hadronic calorimeter to veto rare photonuclear reactions. This talk will summarize the small-scale detector concept for LDMX, ongoing performance studies, and near future prospects.

Session:

Works in Progress (15+5 min)